

A Systems Approach to Water Resources Draft for Discussion



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Executive Summary

Climate change, underfunded infrastructure, outdated management approaches, and the pressures of urbanization are creating a looming crisis for America's water. Because of these multiple changes, a fundamental shift is needed from traditional, heavily engineered and segregated approaches to integrated, systems approaches that work with nature and provide multiple benefits. This paper outlines preliminarily steps toward a new national water agenda including new financing strategies and recommendations for policy reform.

Water in Crisis

The looming crisis in water is no longer an abstraction for many Americans. Aging infrastructure, growing populations and shifting patterns of settlement, and increasing costs are rapidly making water management one of America's leading infrastructure problems. A changing climate is compounding these problems, skewing precipitation patterns that guided earlier engineering and making water scarcity and water-related natural disasters topics of concern in every region in the country. Even in the water-rich Northeast and Southeast, unprecedented flooding and droughts exacerbated by poor investment decisions are causing serious problems.

Several key challenges are pushing the country past the point of peak water – where demand for drinking water and other beneficial uses outstrips available supply. These include: population growth and migration, insufficiency of capital investment approaches, and climate change.

Population growth and migration are driving new water infrastructure needs and creating new planning and environmental challenges. Over 70 percent of population and employment growth between now and 2050 is expected to occur in the nation's 11 sprawling megaregions, significantly increasing demand for water supply in these urbanizing areas. A GAO report noted that 36 state water managers

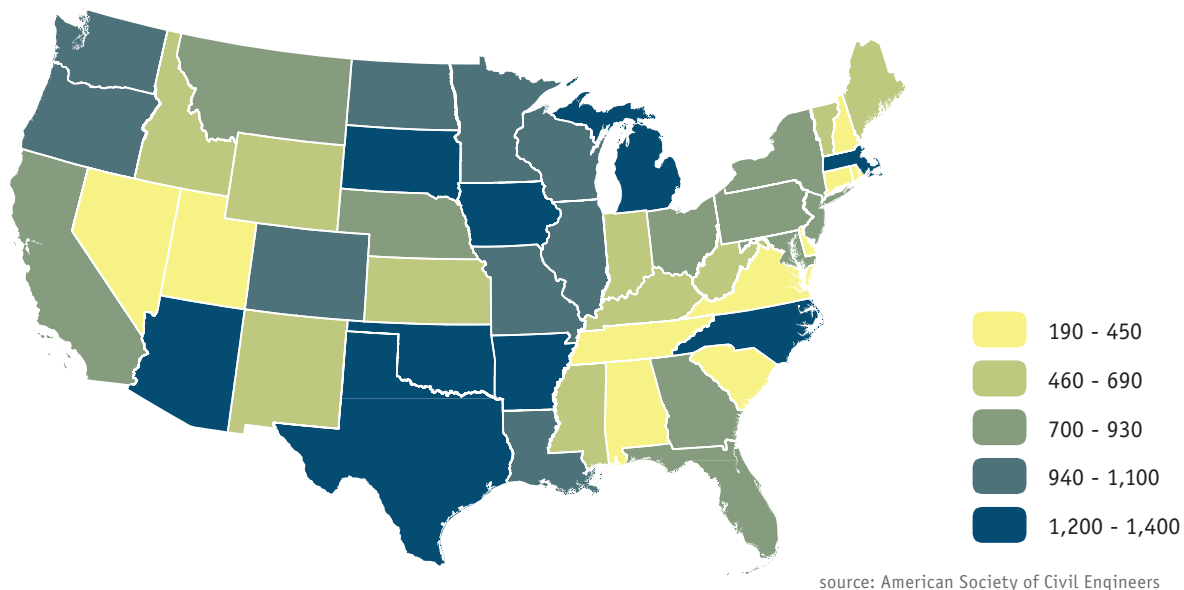
forecast significant water shortages – even in normal years. Ten more states foresee shortages in drought years.¹ A recent Scripps Institution for Oceanography report estimated that there is 50 percent likelihood that Lake Mead, the enormous reservoir of Colorado River behind Hoover Dam that serves over 30 million Americans, could be dry by 2021.² Areas in the Southeast are experiencing water shortages despite relative water abundance, due to a lack of institutional and financial willingness to face the realities of over-burdened, finite water resources. Even in seemingly water-rich locations like the Northeast, exurban sprawl into drinking watersheds is requiring new infrastructure upstream, while degrading quality for downstream urban areas.

Much of the country, especially urban centers that should be the focus for new development and population growth, suffer from impaired water quality and uses. The most serious clean water issues occur in water bodies where older combined sewers, diffuse non-point urban stormwater, and growing runoff of agricultural pollutants have remained largely uncontrolled **by traditional capital investment approaches**. Improvements to many of these receiving waters, such as Puget Sound, the San Francisco Bay-Delta, the Everglades, the Great Lakes, Chesapeake Bay and the Gulf of Mexico, will require complex, multi-stakeholder strategies, increased investments and the application of new scientific and ecological insights.³

Water-related biodiversity continues to face growing stresses, from pressures to divert critical water supplies to agriculture and urban uses, from the loss of wetlands and other critical water habitats, and from misguided and obsolete notions of stream engineering. Learning to use green infrastructure – and the services that such functioning ecosystems offer, from fisheries and recreation to water purification and flood protection – has yet to gain mainstream acceptance in American water resource management. Disputes over regulating base flow water levels essential to commercial and non-commercial species are common throughout the West, and increasingly, the East as well.

Most significantly, **climate change** is already altering hydrologic cycles and the dynamics of water decisions. The reliability of water supplies has been reduced, and will continue to be in the future. Warmer temperatures and changing precipitation patterns will reduce annual snow packs and increase evaporation, lowering storage capacity of reservoirs and watersheds. Weather extremes will occur with greater frequency, stressing not only humans but

FIGURE 1: Drinking water investments needed per capita



also wildlife and natural systems. Sea level rise and higher intensity storms will steadily increase risks on the coasts and inland. Adapting to these impacts may be the most critical development issue facing the country as population and economic growth is greatest in these areas. Flooding and severe storms will incur even greater costs above the billions of dollars of damage this nation experiences each year. This is compounded by land use decisions that allow construction in flood-prone areas and a reliance on levees and other engineering structures built in opposition to, rather than as a complement of, natural hydrological dynamics. Federal and state flood insurance and disaster relief policies have allowed developers to avoid the financial consequences of such unwise decisions by subsidizing such developments from the public purse.⁴

We face these challenges at a time when the financing of our water infrastructure—after decades of progress—is also in crisis.

The landmark 1972 Federal Clean Water Act and subsequent federal and state policies allowed the United States to make enormous strides in reducing pollution from municipal and industrial sources. According to the U.S. Environmental Protection Agency (EPA), pollutant discharges are half of what they were in 1970, despite waste loads that have grown by a third. Cleaner water has benefited public health, created new recreational opportunities, improved fisheries and wildlife habitat, and spurred waterfront investment and development. These achievements are directly tied to a concerted political effort and officially mandated investments in water resource infrastructure and water resource management. The EPA estimates that public spending on water systems has doubled since 1970 and spending on wastewater systems has tripled.⁵

But starting in the mid-1980s, the federal government signaled its intent to remove itself from the financial equation. By underwriting the creation of revolving loan funds administered by the states, public and private clean water

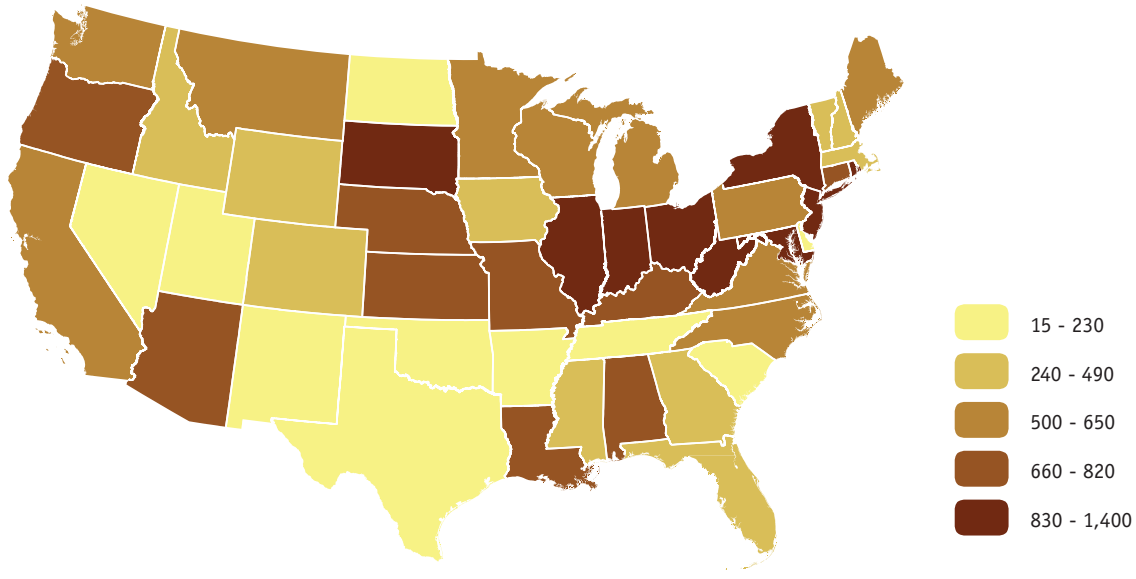
agencies were to be weaned from federal funding, and the public would start to pay a more realistic cost for clean water. While the federal government never contributed more than a fraction of the funding spent on clean water, its participation was crucial to driving local investment to meet environmental mandates.

This disengagement is happening just as the nation's clean water infrastructure is feeling its age. Many urban areas still rely on distribution systems installed in the late 19th and early 20th century. In some cities, 20 percent or more of expensively treated water leaks out of pipes before it ever reaches a home or business. And now these older urban areas have new competition for limited public funds. The massive infrastructure investments of the 1970s are nearing the end of their useful life, and will soon require renovation or replacement.

Addressing these needs will be expensive. The EPA has projected a gap of a minimum of \$534 billion or about \$27 billion a year to meet both capital and operating needs for clean water infrastructure over the next 20 years. This gap assumes federal, state, and local sources continue to invest at past rates, which have averaged about \$19 billion a year since 1970. Subject to much discussion and debate is the relative role and responsibility of Federal, state, and local government, utilities, developers, and ratepayers to meet future financial needs.

Of course, providing clean and safe water is just a fraction of the nation's bill for water resources. The Association of State Dam Safety Officials (ASDSO) has identified more than 10,000 high hazard potential dams in need of repair or removal. They estimate the needed investment for repair at \$16 billion.⁶ A recent evaluation of the federal flood insurance program has noted that the program has suffered a net loss of \$16 billion in FY 05, 06, and 07.⁷ And the added exposure due to climate change and the cost of preparing for those changes will add billions more.⁸

FIGURE 2: Waste water investments needed per capita



source: American Society of Civil Engineers

One critical factor in addressing capital and operating costs are likely increases in the costs of energy, as well as the way that water and energy are interlinked. As water shortages rise and stores of clean water become more stressed, it will be more expensive to transport, clean, and heat water. It is estimated that such activities consume 13 percent of our total national energy supply.⁹ As more communities turn to desalination and water recycling technologies the energy embedded in each unit of treated water will rise. At the same time, the need to reduce carbon emissions will drive up demand for hydroelectric, solar, natural gas and biofuels, which all require substantial amounts of water. Continued use of traditional supplies of energy such as coal and nuclear will further strain water supplies since the energy sector consumes more water for thermoelectric cooling than any other sector in the United States. Rising energy prices will drive up the price of water and rising energy demand will consume more water—both influencing a range of investment decisions.

Scarce dollars underscore the need to make smarter investments. Even full funding for the system will not address several vexing problems. An increasingly complex set of water problems requires a policy framework that aggressively promotes integrated management of water – from mountain headwaters to downstream estuaries.

Our current approach relies on prescribed legislative standards and agency specific project evaluations. For example, the National Academy of Public Administration has catalogued an unfunded backlog of \$60 billion in existing and approved Army Corps of Engineers projects to improve water-borne transportation, provide for beneficial uses, and control flooding.¹⁰ How these individual projects relate to Clean Water Act, Safe Drinking Water Act, Endangered Species Act, or other legislative standards is not generally a consideration in their formulation. Their contribution to overall watershed health, long term urban development

goals, or adaptation to a changing climate is even less clear. Management and appropriation decisions are made in a fog of sometimes conflicting goals and requirements and the annual funding is only a fraction of the existing need.

Because of the multiple challenges of policy, management, and finance, there must be a fundamental change from traditional, heavily engineered and segregated approaches to water resources. Our goal must be to create integrated systems where water supply, wastewater treatment, stormwater management, flood control and habitat restoration are addressed comprehensively. We must create systems that work with nature and benefit from the sustainable ecosystem services that a healthy environment can provide.

Treating Water as Water

The nation needs a new national agenda for water, one that increases investment in the right mix of traditional and innovative green infrastructure approaches. We cannot afford to rebuild or create new infrastructure modeled after designs from the 19th and 20th centuries. As noted in a recent Aspen Institute report,

A crisis-driven approach, based on the “investment gap” analysis, will be insufficient to meet the growing challenges facing the nation’s water infrastructure. Rather than looking ahead with apprehension, a new framework that looks ahead with intention, by reframing the issue from one focused solely on an “infrastructure gap” towards a more sustainable model or approach to funding water and wastewater infrastructure, is needed.¹¹

A 21st century water agenda demands an holistic and integrated approach that links water resource management goals throughout the watershed, and with other community goals such as economic prosperity, public safety, and quality of life.

A broader and more encompassing definition of water infrastructure is the first step. Pollution prevention, water conservation, appropriate pricing, improved management effectiveness and efficiency, and green infrastructure can often provide far greater and more diverse benefits than traditional single-purpose approaches at a far lower cost. These policies have important secondary benefits, including saving energy used to treat and transport water, protecting and restoring ecosystem services, lowering vulnerability to flooding and reducing the growing costs of disasters, and creating local jobs, such as those created by retrofitting commercial buildings and homes with water-efficient fixtures.

Creation of a new national water policy must start with the acknowledgement that “water is water”. The traditional division of responsibilities between drinking water, irrigation, transport, stormwater, and wastewater are artificial constructs that narrow the potential for innovative, sustainable solutions.

But if the need for a comprehensive approach is clear, the ways and means of implementing such a policy are considerably murkier. Most water resource capital decisions—from conception to financing—are made by individual, single-purpose agencies following traditional cost sharing requirements and project-focused planning guidance. Stove-piped regulatory authorities make it difficult even within agencies to manage water effectively. For instance, there are disjointed rules that govern groundwater and surface water even though they are inextricably connected. Understandably, these agencies are sometimes loath to take on added operational responsibilities and liabilities. Design and engineering professionals have made great strides in developing and implementing pilot projects that encourage efficient resource use, utilize pricing and markets, and address the implications of land use and climate change. But institutionalizing this new policy framework and planning approaches requires decision makers to operate outside of their traditional silo and lines of responsibility.

A recent evaluation of the Army Corps of Engineers project evaluation process by the National Academy of Public Administration¹³ found that typical multiple-criteria evaluation techniques for comparing the individual projects are unlikely to produce optimal system performance. Instead, they lead to a laundry list of individually conceived and sponsored projects. As a result of this fragmentation, public policy is too often made project by project, and on the basis of political considerations rather than strategic evaluation. The result is inefficiency, duplication, waste, and often serious economic, environmental and social consequences. As has been poignantly noted, very few individual levees failed in New Orleans during Katrina.¹⁴ What failed, and what doomed New Orleans to its horrific flooding, was a massive “system failure,” caused by a few weak links in a system that existed in name only.

The limitations of a project-centric, single-purpose approach are generally less dramatic, but the missed opportunities and unintended consequences are certainly widespread. Many experts recognize that the enormous capital expenditures being allocated to eliminate combined sewer overflows through underground storage or sewer separation would result in broader environmental benefits in a more cost effective manner had they been managed by protecting small headwater streams or integrating a system of urban rain gardens and green roofs that also provide urban cooling, reduce flooding, and make communities more appealing. The greatest current barriers to meeting the nation’s water quality goals are diffuse non-point sources like runoff from farms and urban uses, sources that can only be effectively addressed through a watershed-based, integrated approach.¹⁵ Flood risk and stormwater are best managed on a strategic and cost effective regional scale, where solutions are not limited to on-site detention and storage.

Key to enabling this holistic approach is policy reform that links water resource management to land use decisions. In too many areas of the country, considerations about the future of a locality proceed independently from decisions about water supply, waste water disposal, or flood risk. While water is generally an enabling or limiting factor for advancing individual projects, the cumulative impacts and collective responsibilities of those decisions are rarely accounted for. With land use power vested in the municipality or county government, the watershed is generally not a basis for decision making. Finding solutions that reach across political boundaries is a universal goal that is rarely reached.

Toward a New National Water Agenda

National water policy choices that will be made over the next several years will determine whether America’s water resource managers, in the face of growing challenges and complexity, can produce safe drinking water for over 300 million Americans, dispose of their sewage safely, provide industry and agriculture with the water it needs, and protect our shorelines and riverfront communities in a way that is both environmentally sustainable and economically affordable.

The task will be to use the successes of the past and the many promising initiatives of the present to create the integrated, multi-dimensional, goal-oriented policies the future demands. The risk is that we will continue to sink huge sums into conventional, inflexible infrastructure that won’t work under highly variable and extreme weather conditions.

While there is broad recognition that such a comprehensive approach is needed, no strong, effective coalition of interests has yet proven able to break the status quo. Federal, state, and local leaders must chart a new path.

To be effective, a national water policy must outline how traditional federal mandates and ongoing capital investments in water management will incorporate non-structural alternatives. It must provide powerful incentives for smarter, systematic approaches that link upstream

and downstream investments, and provide better cost to benefit ratios. Perhaps most critically, it must break down traditional sector responsibilities and insure cost-effective coordination between land use planning and water resource management.

An important first step occurred in the American Recovery and Reinvestment Act of 2009, requiring that 20 percent of all water infrastructure stimulus funds be spent on green infrastructure or water and energy efficiency projects.

We need to build on this progress by addressing two specific sets of issues that will move the nation forward.

1. Reframe decision-making to establish a results oriented, outcome driven watershed approach that meets national goals and standards;
2. Provide funding and incentives to drive efficiency, integration, and innovation to achieve these national goals.

Reframe Agency Decision Making

There is no United States Department of Water. The distinct legislation that has governed water policy in the United States, such as the National Environmental Policy Act, the Clean Water Act, the Safe Drinking Water Act, Water Resources and Development Authority, create a fragmented approach that now prevents further progress from being made on clean water, drinking water, flood protection, and other shared goals.

Promotion of systematic and watershed based approaches to water resource management is not new. It is a longstanding national policy goal as one of EPA's "Four Pillars" for sustaining water infrastructure, and supported by agency efforts to promote green infrastructure and other smart approaches.¹⁷ Section 208 of the Clean Water Act provides for comprehensive regional water quality management planning while Title 9 provides for interstate river basin plans.

In short, there are a lot of instruments on the table, but we do not possess the political will to use them. As noted by the National Association of Clean Water Agencies, "When prioritization of watershed needs occurs, the best use of public and private funds can be made by addressing the top causes of water quality impairment first."¹⁸

Recent evaluations of the Army Corps of Engineers,¹⁹ the Flood Insurance Management Program,²⁰ and the Chesapeake Bay Program²¹ have underscored the importance of this approach. There are proposals to amend the Water Resources Development Act to allow greater latitude for planning-based project initiation by developing five-year fiscally constrained "programs of projects" to implement long range plans.²² The proposed Climate Bill has a number of initiatives that promote integrated planning to address adaptation for flooding and altered flooding regimes. There is a legislative proposal to establish a National Water Policy Commission to engage stakeholders in a deliberative process around these questions.²³

To implement these long-standing agency policies and to realize the potential of current proposals, we need a concerted effort to promote and implement new models of watershed management that link water resource decisions across agencies and to land use decisions.

Such initiatives must have the political capability and the right mix of incentives and directives that make a real impact, including initiatives that:

- Realign our water policies to ensure a watershed perspective that matches the needs to finance infrastructure investments, protect and restore ecological services, promote emerging smart and energy efficient technologies, and align water policies with national and local land use objectives.²⁴
- Establish the ways and means of coordinating the missions and programs of the many federal agencies that affect water resource management, including the EPA, FEMA, the Army Corps of Engineers, USDA's Forest Service and Natural Resources Conservation Service, Department of the Interior's Bureau of Reclamation and Fish and Wildlife Service, NOAA, FERC and others.²⁵
- Break down barriers between traditional infrastructure and natural resource silos. This should include replacing our current cost sharing requirements, project-focused planning guidance, and annual, project-specific, appropriations with performance-based scorecards and other decision making processes that encourage managers to quantify the true costs of single-purpose projects as well as the value of co-benefits. Such cross-sector accounting and credit banking, combined with reforms to building codes, environmental regulations, and political and administrative constraints can increase collaboration across agencies by identifying who owns a particular water resource problem and how they can pay for it.²⁷
- Target investments in 21st century priorities, including green infrastructure and source water protection; water and energy efficiency; climate change adaptation; clean and safe water for economically distressed communities; integrated water management and smart growth approaches to storm water and wastewater management.
- Reform federal policies that provide perverse incentives for unsustainable water resource use and investments including subsidies of pollution-intensive agricultural practices, promotion of vulnerable development on flood plains and in coastal zones, Army Corps of Engineers projects that destroy or disrupt natural hydrological systems that are providing crucial ecosystem services, and suburban sprawl dependent on unsustainable uses of groundwater resources.

Provide Funding and Incentives

The gap in funding is real, substantial, and will only grow as the implications of climate change becomes more apparent. Access to water is both a human right and a utility whose price is subject to supply and demand. Any solution must correspond to the imperative to protect human health as well as reflect the true cost of water and healthy water resources.

Our response must provide the needed resources, but do so in a way that drives efficiency and innovation by making federal assistance conditional on implementing needed reforms.

The nation needs a new water financing strategy that:

- Addresses the current gap in clean and safe drinking water funding;
- Underwrites the steps needed to address the current risk of flooding while adapting our infrastructure for a changing climate;
- Encourages water efficiency and reduces pollution through selective taxes and fees on adverse uses;²⁸
- Provides federal funding conditionally, predicated on actors taking the initiative to establish an integrated, watershed based approach.

Other critical utilities in the United States, such as transportation and land conservation, have dedicated trust funds that provide an ongoing stream of capital funds by assessing fees and taxes on users and activities that detract from the efficacy of the infrastructure. Such a dedicated trust fund for clean water is currently under consideration by Congress.²⁹ Water has also been considered as an element for national infrastructure bank.

Establishing a water trust fund is one approach that could address the current gap in clean and safe drinking water funding. It could help underwrite the steps needed to address the current risk of flooding while adapting our infrastructure for a changing climate. It can encourage water efficiency and reduce pollution through selective taxes and fees on adverse uses.³⁰

Any new trust fund will only provide part of the funding stream that is needed. Other water financing strategies will need to be considered as well. Whether outright public funding, low interest loans, or leveraging private capital for more sustainable investments, these mechanisms should address the following specific policy reforms:

- **Promote new models** of watershed management at the regional and megaregion scale that link water resource management to land use decisions. Individual project earmarks should be replaced with division-by-division appropriations scaled to meet the strategic performance priorities of those watersheds and conditional on implementation of land use practices and policy reforms.

- **Redirect annual federal block grant funding** to states to reward projects that take an integrated approach to managing water quantity and quality; flood and other wastewater and beneficial reuse, and that utilize green infrastructure and water efficiency as central elements.
- **Evaluate projects based on the life-cycle costs** of the investment: the total capital, operations and maintenance and replacement costs needed to achieve specific outcomes. Provide set-asides for projects that encourage cross-sector collaboration and significant co-benefits. This could enable the regulatory systems to migrate from mandating specific single purpose design components to outcome-based requirements.
- **Provide funding for protection and restoration** of essential natural water infrastructure—headwaters, small streams and wetlands, floodplains—through rate structures and other conventional infrastructure funding means.
- **Substantially increase R&D funding** in non-structural and decentralized technologies and their commercial application to ensure that the United States can compete with other nations who are far ahead of us in developing and utilizing integrated water technologies. Such funding could be combined with tax credits and other incentives to stimulate private sector investment, develop new green infrastructure technologies, improve economies of scale, and boost wide-scale implementation.

Moving Forward

The crisis in water is real, substantial, and imminent. Whether it is use restrictions in the West, flooding in the South and Midwest, or coastal erosion in the Northeast, water is in the news, and not in a positive way. Freshwater scarcity is rapidly becoming an issue of national urgency that we have not fully grasped. Water can no longer be a sidebar in national infrastructure discussion. By some estimation, it is fast becoming the most critical need.

If droughts persist, sea levels continue to rise, and coastal storms strike harder, as they surely will, the nation will be forced to deal with water. Unfortunately, it sometimes takes a dramatic and tragic moment to move a nation forward. Katrina has sparked a reexamination of our flood policies, just as the 1938 Long Island Express hurricane spawned a series of tidal barriers in New England. The devastating North Sea storm of 1953 prompted national commissions and massive investments in the Netherlands and Britain. In Australia, the current 13 year drought led to changes in the federal constitution and other substantial changes to the overall legal framework of water rights and pricing. One hopes that the country can move forward without such tragic motivation.

The existing agencies and policies have spawned a growing number of examples of integrated water management and resources management initiatives from Oregon to California to New York to Florida. The stimulus funding provided by the American Recovery and Reinvestment Act provided incentives to further enhance these efforts. This growing culture of innovative green practices provides a foundation for a new national framework.

But without leadership and accountability at the national level these efforts will not meet the deepening challenge of our current situation. The fundamental conundrum is how to establish a national agenda with so many federal agencies and so many federal programs having jurisdiction. Establishing a national perspective and goals; integrated and outcome-based management approaches; and financial incentives conditioned on meeting these goals provide a basis for mobilizing the growing awareness and acceptance of innovative, smarter practices. It can drive the success of a national water policy that touches all aspects of our life.

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